

## UNC Charlotte – Lee College of Engineering Senior Design Program Company Information

<b>Company Name</b>	<i>Barrday Corp.</i>	<b>Date Submitted</b>	<i>5/18/2020</i>
<b>Project Title</b>	<i>Weft cutting optimized for aramid yarns on airjet weaving machines (BARR WEFT)</i>	<b>Planned Starting Semester</b>	Fall 2021

### Senior Design Project Description

<b>Company Name</b>	<i>Barrday Corp.</i>	<b>Date Submitted</b>	<i>xx/xx/201X</i>
<b>Project Title</b>	<i>Weft cutting optimized for aramid yarns on airjet weaving machines</i>	<b>Planned Starting Semester</b>	Spring 2021

### Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

<b>Discipline</b>	<b>Number</b>	<b>Discipline</b>	<b>Number</b>
Mechanical	3	Electrical	2
Computer		Systems	
Other ( )			

### Company and Project Overview:

Barrday is a leading advanced materials solutions company whose product lines encompass applications for the composite and protective markets. Key data:

- Highly innovative, technical and capable partner
- 60 year history
- Serves a wide range of advanced markets with focus on Protective, Composite and Energy
- International presence with differentiated capability
- Manufacturing expertise in fiber reinforcements, prepregs, laminates, coatings, adhesives, sealants and core materials



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## Key Markets

### Protective

- Body Armor
- Stab/Spike
- Vehicles/Helmets/Plates
- Fire Protection



### Composite

- Commercial & General Aviation
- Ablatives
- Automotive/Transportation
- Marine

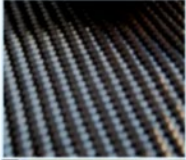
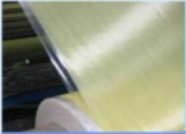
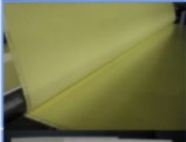


### Energy

- Wind Blades
- Solar Films and Adhesives
- Tidal Blades



## Advanced Material Solutions

	<b>Fiber Reinforcement</b>	<ul style="list-style-type: none"> <li>•Carbon, aramid and other high performance specialty fiber reinforcements</li> <li>•Ability to modify and custom design fiber reinforcement solutions for specific applications</li> <li>•Available greige or combined with resin system</li> <li>•Proprietary and patented fiber reinforcement technologies</li> </ul>
	<b>Prepregs &amp; Laminates</b>	<ul style="list-style-type: none"> <li>•Unidirectional &amp; fabric prepregs</li> <li>•Thermoset and thermoplastic resins including epoxy, phenolic, vinyl ester, urethane, acrylic, polyester, polyethylene and BMI</li> <li>•Solution, film and powder coat technologies</li> </ul>
	<b>Coatings Adhesives &amp; Sealants</b>	<ul style="list-style-type: none"> <li>•Standard and custom mixing capabilities</li> <li>•Custom formulations</li> <li>•Solvent and water based</li> </ul>

Barrday has 4 locations. This project would be done with our Charlotte location. The Charlotte location has 2 main product families, woven and non-woven.

This project will be for the woven product family, specifically fabrics woven from aramid yarns.

### **Project Requirements:**

Mankind had been weaving for thousands of years and the basic structure of our most commonly woven fabrics is still the same but the rate at which we can produce these fabrics has increased dramatically. The most advanced modern weaving machines are capable of inserting 2000+ yarns per minute in the weft or 90 degree direction. Barrday's weaving machines are capable of 1000+ insertions per minute but we are only able to run them at 600 insertions per minute for the products we run.



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Barrday's weaving operations almost exclusively weave aramid yarn into ballistic fabrics used in body armor, helmets and vehicle armor. The very characteristics of aramid that make it well suited for ballistic performance are the same characteristics that make it difficult to cut. Weaving machine manufacturers have optimized their machines for weaving high volume commodity fabrics such as those used in clothing or home decor. These products are not made from high performance yarns and the yarn materials are relatively easy to cut. The standard insertion or weft scissors on weaving machines fail to make acceptable cuts on aramid yarns above 600 insertions per minute rate. Aramid fabrics are a tiny fraction of the world's weaving industry so finding a better way to cut aramid weft yarn has not been a priority for the weaving machine manufacturers.

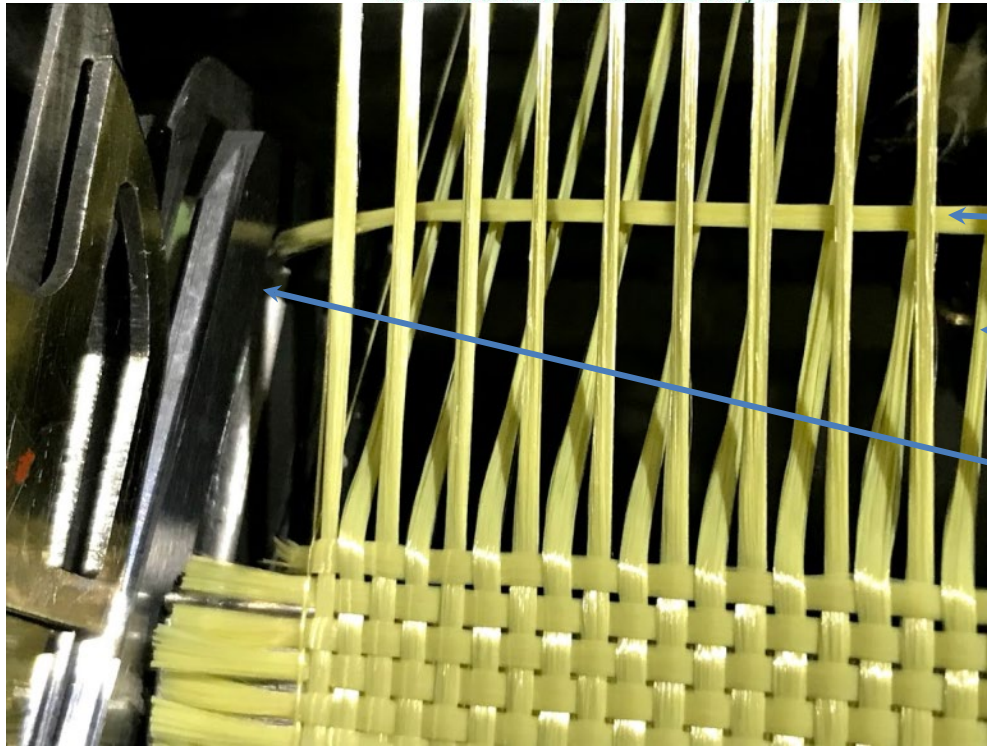
In air jet weaving specifically, the weft yarn is pushed across the width of the machine by air pressures, via air nozzles. The cutters are designed to cut the weft yarn at an exact time to keep the machine running efficiently. The cutter's job is to separate the useable body fabric from the selvage waste.

The purpose of this project is to design a better cutter solution that will allow higher weaving speeds with aramid yarn.

The design constraints around making a better cutting solution are numerous:

- Limited space on machine
- Precise timing and a short cutting time window
- Cut must be very clean and uniform and repeatable for the weaving process to work correctly
- The cutters must be able to be adjusted in/out to accommodate different width fabrics
- Solution must be robust enough to operate in a 24/7 environment and simple enough for the existing machine technicians to set up and troubleshoot
- Retrofit cost per machine for the new cutting solution is less than \$3000. Barrday has 50 weaving machines that the solution could be applied to.
- Solution must be safe for operators to work around

Barrday has access to a retired expert from the weaving machine manufacturer who can provide access to the machine control software and guidance on integrating the solution into the machine HMI.



Weft yarn

Warp yarn

Existing carbide scissor style weft cutter



Zoomed out view of weft cutter area

**Expected Deliverables/Results:**

- Working prototype of a cutting system that allows a weaving machine to run at 800+ insertions per minute using 1000dTex or larger yarn with less than 2 machine stops per 12 hours due to poor cutting.
- Prototype is to be integrated into the weaving machine control system
- Full set of mechanical and electrical documentation required to manufacture and install the cutting system.
- Instructions for operating and maintaining system.



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- The cutting surface must be able to be re-sharpened or have a life of greater than 1 week.
- Have manufacture of the cutting system quoted for a quantity of 50 systems.
- Report detailing :
  - the design decisions and tradeoffs made to arrive at the final solution
  - an overview of failed solutions and explanation of why they failed
  - recommendations to further refine the final solution

**Disposition of Deliverables at the End of the Project:**

All hardware developed, programming, CAD models and reports are to be delivered to Barrday at the end of the project after displaying at the expo.

**List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):**

- 3D Modeling – SolidWorks
- Any IP that results from this will be owned by the supporter
- 2D Electrical Software
- Mechanical Aptitude to assemble and build equipment
- Ability to travel to Charlotte, NC for review/build of equipment.